OSTEOPOROSIS RISK FACTORS IN RURAL AND URBAN WOMEN FROM THE LUBLIN REGION OF POLAND

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Abstract: In various epidemiological and clinical studies, bone quality, bone mineral density (BMD), as well as risk of falling have been associated with lifestyle and anthropometric/demographic characteristics. The objective of this study was to evaluate the osteoporosis risk factors occurrence and its association with BMD in rural and urban women from the Lublin Region in Poland. A cross-sectional study of risk factors of osteoporosis and fracture was carried out in a cohort of 900 rural and urban women aged 30–79 years, representative of the general population the Lublin Region. Data pertaining to osteoporosis risk factors as well as medical history were taken using a specially designed 31 item questionnaire divided in seven sections: social history, past medical history, reproductive history, drug history, family history of osteoporosis, nutritional habits and lifestyle factors. The lumbar spine (L_2-L_4) was examined in a-p position using the dual X-ray absorptiometry- DXA (LUNAR Corp.). The differences between urban and rural women in the appearance of particular osteoporosis risk factors, such as gynecological, dietary calcium intake, smoking and coffee consumption, was noticeable. Age, years of menopause and family history of osteoporosis (in mothers) were found to have strong negative independent associations with lumbar spine BMD. Body Mass Index (BMI) was found to have strong positive association with BMD. Dietary calcium intake, coffee consumption and level of physical activity had noticeable positive and independent, but not significant association with BMD.

INTRODUCTION

The main complications of non-diagnosed osteoporosis are fractures, which constitutes a major health problem in terms of suffering and in terms of use of resources [13]. The risk of osteoporotic fractures depends on two main determinants: bone quality and risk of falling. In various epidemiological and clinical studies, bone quality, bone mineral density, as well as risk of falling have been associated with lifestyle and anthropometric/demographic characteristics [19, 32]. The possible mode of action of these factors is direct or indirect effects on bone metabolism or by modifying the impact of physical trauma from falls [8]. For example, women's reproductive history, such as age of menarche and menopause, may have an indirect effect on bone metabolism by determining lifetime exposure to estrogens. Other factors, including alcohol consumption, cigarette smoking, and family history of osteoporosis, may influence both hormonal and anthropometric characteristics. Several retrospective and prospective studies showed relatively consistent association between anthropometric/demographic characteristics

and bone mass and fractures [1, 12]. Larger body mass African American racial background are proven protective factors against osteopotic fractures [5, 47]. The other factors such as physical activity, reproductive history, cigarette smoking, coffee consumption, alcohol consumption, dietary Calcium intake, have not been profoundly studied in case-control studies, therefore their influence is less certain [9, 22, 55],

Rural and urban populations differ in the occurrence of several diseases including cancers, POCHP, alveolitis and coronary heart disease [51, 53]. Differences in rural and urban hip fracture rates have been reported between communities in Northern America, Asia and Scandinavia. In most of the studies, lower fracture rates were noticed in rural communities and increasing hip fracture rates in Asia have been attributed to increasing urbanisation [16, 31, 37, 39, 50].

The primary aim of this study was to evaluate the osteoporosis risk factors occurrence and its association with BMD in rural and urban women from the Lublin Region in Poland.

MATERIALS AND METHODS

A cross-sectional study on risk factors of osteoporosis and fracture was carried out in a cohort of 900 rural and urban women aged 30–79 years, representative of the general population the Lublin Region in Poland. Women were drawn from the computer census in Lublin (urban population) and Urzędów (rural population) Town Halls. Urzędów district was chosen because of its typically rural features such as: 40 kilometres from the nearest town, lack of industry, significant percentage of farmers. Data pertaining to osteoporosis risk factors as well as medical history were taken using specially designed 31 item questionnaire divided in seven sections: social history, past medical history, reproductive history, drug history, family history of osteoporosis, nutritional habits and lifestyle factors. The questionnaire included lifestyle variables followed over the last 10 years that were considered predictors of bone mass, according to previously published clinical and epidemiological studies. The physical activity level was evaluated by estimation of the sports and gymnastic activity, as well as physical load during work. The time spent on physical activity was categorized as: never, occasionally (twice a week for at least 60 minutes), and permanently, (more than twice a week for at least 60 minutes). The mean daily consumption of diary products was specifically estimated for milk, butter milk, yogurt, soft and hard cheese to calculate the mean diary calcium intake in milligrams per day [19]. Participants were also questioned about all dietary supplements they were taking, including vitamin use. Present and prior cigarette use was determined by the number of cigarettes per day. Coffee consumption was measured in cups per day. Alcohol consumption was categorized as: every day, once a week, once a month and never. All participants were asked their age of menarche,

age of menopause (physiological or surgical) as well as present and prior estrogene therapy. The patients were asked whether they were on chronic therapy with any drug, and were specifically asked about corticosteroids, thyroxin, warfarin, immune-suppressors, thiazides and antiresorptive drugs. During completion of the questionnaires, a medical doctor was available for those who were unable to fully understand the questions. The questionnaire for physical activity, daily calcium, caffee, alcohol intake, as well as cigarette smoking was validated in 50 subjects, using a more sophisticated questionnaire completed by study participants with the assistance of a study nurse. The differences between the results of the two questionnaires were negligible.

All women passed the physical examination as well as body weight and height measurement. The lumbar spine (L_2-L_4) was examined in a-p position using the dual X-ray absorptiometry- DXA (LUNAR Corp.) at the Densitometric Laboratory of the Institute of Agricultural Medicine in Lublin.

Statistical analysis. Statistical analysis was performed using regression analysis and analysis of variance with software Statistica 5.0. The Students test was used to examine the significance of differences between groups for non-paired data. Probabilities $p \leq 0.05$ were considered significant.

RESULTS

This article reports data pertaining to the 503 women who passed all procedures according to the study protocol and correctly completed by more than 80 percent of the questionnaire.

Menopause, menarche, number of births. The mean menopausal age in the analyzed population was 46.3 years. In the rural subgroup, the mean menopausal age was one year less compared with the urban subgroup (Tab. 1). Total percentage of postmenopausal women was 41.7%. Mean lumbar spine BMD values were significantly higher in women before menopause. In women after menopause, mean spine BMD decreased significantly with years after menopause (Tab. 1). By multiple regression analysis, menopause was an independent significant predictor of lumbar spine BMD (Tab. 4).

The mean age of menarche in the analyzed population was 13.9 years. In the rural subgroup, the mean menarche age was one year more compared to the urban subgroup (Tab. 1). Mean spine BMD values were highest in the subgroup with menarche appearance between 12-15 years of age; however, the lowest were in the subgroup with menarche appearance before 12 and after 15 years of age. There were no statistically significant differences in lumbar spine BMD between subgroups with menarche before 12 and after 15 years of age.

The mean number of births in all the analyzed population was 2.14, and was bigger in rural compared to

Table 1. General characteristics of the study population.

	Mean (SD)	Min.	Max.
Age (Years)	49.5	30	79
Height (cm)	162.3	140.0	176
Weight (kg)	70.3	30	120
BMI (kg/m^2)	26.6 (4.36)	15.8	42.6
BMD L$_2$-L$_4$g/cm^2	1.166 (0.18)	0.655	1.812
Age at menopause			
General	46.3 (5.64)	26	65
Rural population*	45.9 (6.64)	26	65
Urban population**	46.7 (5.21)	29	65
Age of menarche			
General	13.9 (2.62)	10	19
Rural population*	14.3 (1.56)	11	18
Urban population**	13.6 (3.13)	10	19
Number of births			
General	2.14 (1.22)	0	9
Rural population*	2.7(1.13)	0	9
Urban population**	2.12 (0.87)	0	7

*n=221(43.4%), ** n=282 (56.06%)

Table 2a. Dietary calcium intake in milligrams per day in rural and urban women from Lublin Region of Poland.

	Rural population	Urban population	General population
Mean	546	455	495
SD	438	349	393
n	221	282	503

Table 2b. Dietary calcium intake in milligrams per day in selected age ranges of women from Lublin Region of Poland.

Age range	Ca in nig/day
30-39	471
40-49	451
50-59	522
60-69	631
70-79	569

urban women (2.70 and 2.12 respectively) (Tab. 1). No significant relationships were found between lumbar spine BMD and number of births in the analyzed population.

Dietary calcium intake. Mean dietary calcium intake in the analyzed population was estimated as 495 mg per day. In the rural subgroup, mean dietary calcium intake was approximately 100 mg/daily higher compared to the urban subgroup (546 mg/daily and 455 mg/daily respectively). Pertaining to the age of participants, the biggest dietary calcium intake was noticed in women

between 60–69 years of age, and the lowest in women between 40–49 years of age (631 mg/daily and 451 mg/daily respectively) (Tab. 2a and 2b). It is noteworthy, that 8.5 percent of the analyzed population showed absolute lack of any milk derivative products consumption.

Coffee consumption, cigarette smoking. 27.8 percent of the analyzed population did not report coffee consumption, 14.5 percent drank 1 cup of coffee daily, 37 percent drank 2 cups of coffee daily, and 20.7 percent drank more than 2 cups of coffee daily. In the subgroup drinking more than 2 cups of coffee daily there was a visible predominance of urban women (75%) compared to rural women (25%); however, the predominance of rural women was visible in the subgroup which did not show any coffee consumption.

75.5 percent of the analyzed population did not report smoking, 5.1 percent reported smoking less than 5 cigarettes daily, 6.3 percent reported smoking from 6–10 cigarettes daily, while 12.3 reported smoking more than 10 cigarettes daily. In all smoking categories (less then 5, from 6–10, and more than 10 cigarettes daily), a higher percentage of urban women was noticeable.

Level of physical activity. A very low level of physical activity in all the analyzed population was noticeable. Frequent sports activity (2 or more times weekly), was reported by only 3 percent, and occasional (1 or less weekly) sports activity, reported by 4.8 percent of women. 92 percent of all analyzed women did not report any physical activity. The sport disciplines reported by study participants were: jogging, biking, volleyball, aerobics, tennis, swimming and gymnastics. Everyday exercising (gymnastics) were reported by only 8.3 percent of women, and in the urban population this percentage was twice as big compared to the rural population (10.3% and 5.8% respectively). Once weekly exercising (gymnastics) was reported by 10.5 percent of women, and 76.3 percent of women did not exercise at all. Comparison of mean lumbar spine BMD between women under 60 years of age with high and low level of physical activity, after adjusting for age, showed bigger BMD values in women with a high level of physical activity, but the difference was not statistically significant (mean BMD values 1,213 g/cm^2 *vs.* 1,165 g/cm^2) (Tab. 3 and 3b).

Diseases and drugs affecting bone tissue. 17.8 percent of the analyzed population had a history of diseases potentially affecting bone tissue. The most common were: thyroid pathology in a total of 5.9 percent (including 2.4% of hyperthyroidism, 1% of hypothyroidism and 2.4% of thyreidectomy), stomach and duodenum ulcers – 5.3 percent, rheumatoid arthritis - 2%, bronchial asthma – 1.2%. The percentage of other diseases, including digestion and absorption disorders, liver disorders, other than rheumathoid arthritis, rheumatic diseases, and parathyroid glands disorders was very low (0.2%–1%).

Table 3a. Sports activity in women from Lublin Region of Poland.

	never		occasionally*		permanently**	
	n	%	n	%	n	%
Rural population	205	92.7	11	5.0	5	2.3
Urban population	259	91.8	13	4.6	10	3.5
General	463	92.0	24	4.8	15	3.0

* twice a week for at least 60 min.; ** more than twice a week for at least 60 min.

Table 3b. Exercise activity in women from Lublin Region of Poland.

	never		everyday*		once a week*		once a month*	
	n	%	n	%	n	%	n	%
Rural population	188	85.0	13	5.8	14	6.3	6	2.7
Urban population	217	76.9	29	10.3	20	7.1	16	5.6
General	384	76.3	42	8.3	54	10.7	22	4.4

* at least 30 min.

Table 4. Predictors of BMD L_2-L_4 (g/cm^2). Results from multiple-linear regression analyses. Underlined beta S[1] with p< 0.05.

	Beta S[1]	SE	P
Age	-0.250	0.001	0.000
BMI	0.439	0.002	0.000
Years of menopause	-0.233	0.003	0.000
Dietary Calcium intake	0.023	0.000	0.700
Smoking	-0.004	0.009	0.948
Coffee consumption	0.007	0.008	0.898
Level of physical activity	0.100	0.022	0.105
Family history of osteoporosis (mother)	-0.129	0.042	0.029

9.3 percent of the analyzed population reported administering drugs affecting bone tissue. The most common were thyreostatics – 2.2%, antiacids – 2.2%, corticosteroids – 2% and L-tyroxin – 2%. 0.8 percent were other drugs, such as cytostatics, isoniazid, and warfarin.

Family history of osteoporosis. A family history of osteoporosis was found in 9.5% of the analyzed population. The most common were osteoporotic fractures occurred in mothers – 6.5%, in sisters and brothers – 1.1%, in fathers – 1.1% and in grandmother – 0.5%.

In multiple-linear regression model was constructed for the lumbar spine (L_2-L_4) bone mineral density. Standard regression coefficient (beta S[1]), standard errors (SE), and significance levels of all items selected for multiple regression analyses are presented in Table 4. Age, years of menopause and family history of osteoporosis (in mothers) were found to have strong negative, independent associations with lumbar spine BMD (g/cm^2), and the

BMI was found to a have a strong positive association with BMD (g/cm^2). The remaining variables, such as dietary calcium intake, coffee consumption and level of physical activity, had noticeable positive independent associations with BMD, but were not statistically significant.

DISCUSSION AND CONCLUSIONS

The current study is one of the largest surveys on osteoporosis risk factors in women conducted in Poland [27, 40, 49]. The inclusion of 503 women from a wide range of ages composing various menopausal conditions allowed the evaluation of the independent significance of age, menopausal status and lifestyle factors, such as dietary calcium intake, smoking, alcohol consumption, level of physical activity as predictors of lumbar spine bone mineral density.

On the basis of this population sample, it was possible to draw conclusions on the direct effects of age on lumbar spine BMD. Not surprisingly, multiple-linear regression analyses provided strong evidence for independent, negative influence of age on all analysed lumbar spine BMD sites (for separate vertebrae L_1- L_4 data not shown), which is consistent with other studies [3, 38].

Previous longitudinal studies have demonstrated the highest annual bone loss during the perimenopausal period, intermediate in the postmenopausal period, and lowest in the premenopausal period [45, 48]. The current study data showed that in both rural and urban women lumbar spine BMD values are significantly lower in women after menopause, and that lumbar spine BMD decreases significantly in the years after menopause.

In some studies, a strong independent association between the number of pregnancies and decreased femoral neck BMD without any significant effect on other skeleton sites was found [54, 56]. In other studies, the number of pregnancies was more strongly associated with increased BMD at all analysed skeleton sites (e.g. femoral neck and total radius) [23]. However, it was concluded that despite this fact, the number of pregnancies was not likely to be an independent risk factor for incidence of osteoporosis in the female population [54, 56]. In our study, it was found that the number of pregnancies had no influence on lumbar spine BMD.

Nutrition, especially calcium intake, is considered to be one of the most important factors in bone maintenance. Some clinical trials using therapeutic doses of calcium demonstrated its beneficial effect on the maintenance of BMD [10, 11]. These facts are not consistent with most epidemiological studies, in which higher calcium intake within usual dietary levels is not protective against fractures [6, 17, 30, 35, 41, 43, 57]. However, a low dietary calcium intake is commonly accepted as a osteoporosis risk factor [6, l7, 25, 26, 30, 35, 41, 43, 57]. In the current study, multiple-linear regression analysis showed a slight positive association with BMD, but was not statistically significant. Mean dietary calcium intake

in the analyzed population was estimated as approximately 500 mg per day, and is similar or lower in comparison with other populations, and simultaneously - lower than recommended [4, 18, 28, 36, 52]. It is noteworthy that rural women had an approx. 20% bigger dietary calcium intake compared with the urban subgroup.

Both cigarette smoking and coffee consumption are considered risk factors for osteoporosis. Smoking decreases bone mass by accelerating natural menopause, modifying estrogen metabolism and decreasing body mass [15, 29, 42]. Some cohort and case-control studies indicate, that cigarette smoking increases the risk of hip fractures among women under 60 years of age [33]. The current study did not show an association of BMD with cigarette smoking or coffee consumption in the statistical analyses (e.g. multiple regression). Both smoking and high coffee consumption were more common among urban women compared to the rural subpopulation.

Physical activity has been proved to have a protective effect on BMD in epidemiological surveys [l, 6, 7, 43, 46]. In both rural and urban women a very low level of physical activity was noticeable. Indirect measurements of the level of physical activity did not show any associations with BMD in the current study.

Strong relationships with family history of osteoporosis have been found, which is in agreement with results of other studies indicating negative correlations between history of osteoporosis in mothers and grandmothers, and BMD [2].

The effect of thyroid hormones on BMD is not clearly established. However, in most of the cross-sectional studies, longitudinal studies, and meta-analyses it has been found that hyperparathyroidism and thyroid hormone replacement therapy have an adverse effect on bone tissue, especially on cortical bone. In the present study, a history of hyperthyroidism and thyroidectomy, as well as the use of thyreoatatics, were the most common among disease-related osteoporosis risk factors [14, 20, 21, 24, 44, 58].

In conclusion, the results indicate that risk factors usually associated in other studies with bone mineral density (BMD) measured by DXA in women, are adequate for both rural and urban women from the Lublin Region of Poland. The most important predictors for bone mass were age, years of menopause and family history of osteoporosis.

Acknowledgements

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